

Selecting Tasks for Evaluating Human Performance as a Function of Gravity

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A challenge in understanding human performance as a function of gravity is determining which tasks to research. Initial studies began with treadmill walking, which was easy to quantify and control. However, with the development of pressurized rovers, it is less important to optimize human performance for ambulation as rovers will likely perform gross translation for them. Future crews are likely to spend much of their extravehicular activity (EVA) performing geology, construction and maintenance type tasks, for which it is difficult to measure steady-state workloads. To evaluate human performance in reduced gravity, we have collected metabolic, biomechanical and subjective data for different tasks at varied gravity levels.

Methods: Ten subjects completed 5 different tasks including weight transfer, shoveling, treadmill walking, treadmill running and treadmill incline walking. All tasks were performed shirt-sleeved at 1-g, 3/8-g and 1/6-g. Offloaded conditions were achieved via the Active Response Gravity Offload System. Treadmill tasks were performed for 3 minutes with reported oxygen consumption (VO_2) averaged over the last 2 minutes. Shoveling was performed for 3 minutes with metabolic cost reported as ml O_2 consumed per kg material shoveled. Weight transfer reports metabolic cost as liters O_2 consumed to complete the task. Statistical analysis was performed via repeated measures ANOVA.

Results: Statistically significant metabolic differences were noted between all 3 gravity levels for treadmill running and incline walking. For the other 3 tasks, there were significant differences between 1-g and each reduced gravity, but not between 1/6-g and 3/8-g. For weight transfer, significant differences were seen between gravities in both trial-average VO_2 and time-to-completion with noted differences in strategy for task completion.

Conclusion: To determine if gravity has a metabolic effect on human performance, this research may indicate that tasks should be selected that require the subject to work vertically against the force of gravity.